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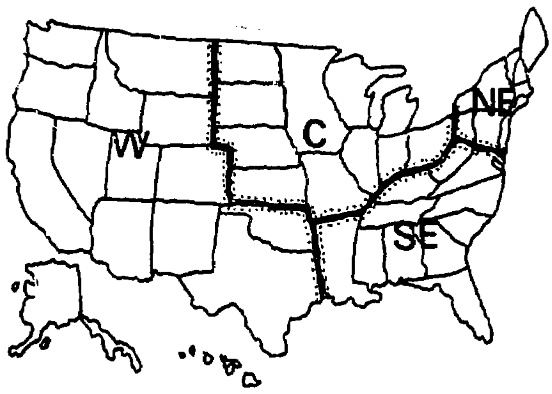
ABSTRACT

The major part of the newsletter contains a summary of the results of the administration of tests in science and writing to students aged 9, 13, 17, and to adults 26 - 35 in all regions of the United States. The data are compared on the basis of regions (North East, South East, Central, and Western); sex of respondent and size of community (big cities, urban fringes, medium sized cities, and smaller places). Males of all ages performed better on the science tests, but females scored higher on the writing tests. The North East and Central regions performed at or above the national average for both sets of tests at all ages. The South East scores were lower than the national average for all ages and both tests. The Western region showed a less consistent pattern, with 17 year olds and adults performing better than the national average on both tests, 13 year olds below on both tests, and 9 year olds at the average for the science tests, but below for the writing. Large cities and "smaller places" respondents were above the national average, with the average for the urban fringe and medium-sized cities above average. The interpretations of a panel of reviewers are summarized, and the limitations of the results indicated. The newsletter also contains announcements about the organization of the project. (AL)

Region, size-of-community, sex results released for science, writing

More men than women know the purpose of a fuse in an electric circuit, but more women than men know the function of the placenta in a pregnant human female. Nine-year-olds living in big cities don't do well when asked to write an essay about a noon walk, but they do as well as all 9s in the United States when asked to write an announcement about a pet show. More 13s in the Southeast than in the whole nation indicate they are often curious about why things are the way they are in nature; more Northeast 13s than all 13s know that the purpose of a scientific theory is to explain why things act the way they do.

These and other results were made public in Chicago in April, when National Assessment released the latest reports on science and writing at the spring meeting of the Steering Committee of the Education Commission of the States, the project's governing organization. Earlier reports released for science and writing presented the national results for these areas. The newest reports describe science and writing group results for geographic region (Northeast, Southeast, Central, and West), size of community (big cities, urban fringes, medium-size cities, and smaller places), and sex. The region and size-of-community breakdowns used by National Assessment appear below.



Big cities—cities with 200,000 or more people;
Urban fringes—areas around big cities;
Medium-size cities—areas around cities with 25,000 to 200,000 people;
Smaller places—areas with less than 25,000 people.

Besides presenting the group results for individual exercises, the newest reports also present results for various classes of exercises. Typical performance of the region, size-of-community (SOC), and sex groups on physical science exercises, for example, is compared with performance on exercises with biological science content. Performance on science exercises focusing on Objectives 1, 2, and 3 (facts and principles, processes, and the investigative nature of science) is compared

New staff director announced

Appointment of a new staff director and creation of a new division have been announced by James Hazlett, NAEP administrative director. See the story on page 5.

Science and writing assessment—facts and figures

Who took part

Responses were obtained from approximately 24,000 9s, 28,000 13s, 28,000 17s, and 8,600 adults aged 26 to 35—about 88,000 in all. Not all exercises were answered by all participants. For each exercise given to 9s, 13s, and 17s, about 2,000 responses were collected; for adults, responses averaged about 850 per exercise. The assessment was conducted between Spring, 1969, and Winter, 1970.

Objectives assessed

in science . . .

1) Know fundamental facts and principles of science.
2) Possess the abilities and skills needed to engage in the processes of science.
3) Understand the investigative nature of science.
4) Have attitudes about and appreciations of scientists, science, and the consequences of science that stem from adequate understandings.

in writing . . .

1) Write to communicate adequately in a social situation.
2) Write to communicate adequately in a business or vocational situation.
3) Write to communicate adequately in a scholastic situation.
4) Appreciate the value of writing.

Kinds of exercises

The majority of science exercises were multiple-choice questions. Other science exercises involved the manipulation of apparatus—such as balance beams, for example—to complete a given task. Still others asked respondents to indicate their beliefs and views relative to various aspects of science. There was no "correct" answer on the latter type of exercise, but one response was judged more desirable than others.

The writing assessment included short-answer questions (such as completing an application blank), self-report exercises (in which the respondent indicated kinds of writing activities he had performed), and essays. Essays were given an overall score based on considerations such as word choice, grammar, depth of thought, and originality of ideas.

Organizations involved

Educational Testing Service, Princeton, N.J., developed the objectives and exercises for both science and writing.

Research Triangle Institute, Raleigh, N.C., developed the random sample design for selecting participants and conducted field operations.

Measurement Research Center, Iowa City, Ia., carried out scoring and data processing and, under subcontract to the Research Triangle Institute, field operations in the Central and Western regions of the U.S.

with success on Objective 4 exercises, which deal with appreciations and attitudes about science. The writing exercises are also analyzed in several combinations—essays versus nonessays, and exercises requiring writing performance versus exercises asking for a self-report of writing activity.

When the results are examined on the basis of classes of exercises, a number of patterns appear among the regions, community sizes, and sexes. Boys, for example, do better on physical science exercises than on exercises with biological science content. Several of the patterns shown by the results for classes of exercises are discussed in the article that begins on page 6.

Performance patterns also appear when the results for *all* exercises given to NAEP's four age groups are summarized and examined. (Typical success for each age-group combination—9s in the Northeast, big city 17s, and so on—on all exercises and on various classes of exercises is summarized by *median performance*. The box opposite includes a brief explanation of the statistics used and comparisons made in NAEP's group reports.) Some median performance patterns are specific to either science or writing, but several cut across both subject areas. A summary follows.

Big cities, smaller places low in science, writing

When size-of-community results on all exercises are examined across ages, one clearly evident pattern is the tendency for people in both big cities and smaller places—the two extremes in NAEP's population subgroups—to perform less well than the nation as a whole, with big cities generally the lowest of the four SOC groups.

Urban fringes and medium-size cities do better, in general, than the nation as a whole. In both science and writing, people living in urban fringes consistently lead the three other SOC groups in comparison to the entire nation.

No between-age SOC patterns occur consistently in the science and writing results. The urban fringe advantage in writing tends to increase as age increases, but in science, urban fringe 17s do not perform as well as their counterparts at the three other ages. The deficit for people in smaller places on writing exercises becomes greater as age increases; in science, the smaller places deficit increases between 13s and 17s and between 17s and adults, but 9s and 13s in this SOC group perform about the same. *continued*

NAEP statistics—short course

Effects and differences

The group results describe comparative performance of the four regions, four community sizes, and two sexes on each science and writing exercise. For region and SOC groups, such performance is described as an *effect*, obtained by subtracting the percentage of success for the group from the national percentage of success on a given exercise. Positive effects indicate an advantage for the group (the group's performance is above that of the nation as a whole), and negative effects indicate a deficit (the group's performance is below that of the nation as a whole).

In a science exercise that required adults to identify adrenaline as a heart stimulant, for example, 69.6 percent of all adults in the country responded correctly. Of the adults in the Central region, 67.6 percent provided the correct answer. The effect for Central adults on this exercise is thus a 2-percent deficit:

69.6% (nat'l correct) – 67.6% (Central correct) = –2% (Central deficit).

Sex comparisons are described as *differences*, arrived at by subtracting female performance from male performance. Positive differences thus indicate a male advantage, and negative differences, a female advantage.

After hearing a conversation in which one of two speakers was asked to write a note for a third person, 74.7 percent of the male 17s wrote an acceptable message containing all the necessary information. Of the female 17s, 82.9 percent wrote an acceptable note. The sex difference for this exercise is thus –8.2 percent, indicating a female advantage:

74.7% (male correct) – 82.9% (female correct) = –8.2% (female advantage).

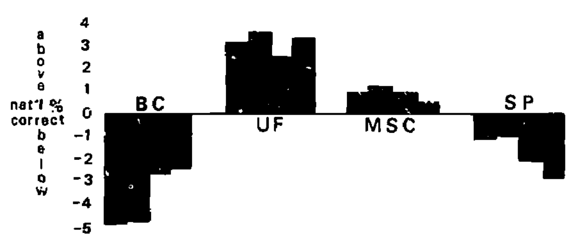
What's typical

The latest results also describe how the population of each group at each age usually, or typically, performs. Data are provided for typical performance on all science and all writing exercises, and on certain classes of science or writing exercises—say, on all biological science exercises. Typical performance is described by the median, a summary figure based on the results for all exercises given to a particular age in a particular group.

For example, 16 writing exercises were given to adults. Half of the effects (national percent correct less group percent correct) for urban fringe adults on these exercises fell above 4.5, and half fell below. Thus 4.5 is the median for urban fringe adults, indicating that on adult writing exercises in general, urban fringe adults typically perform about 4.5 percent better than all adults in the nation.

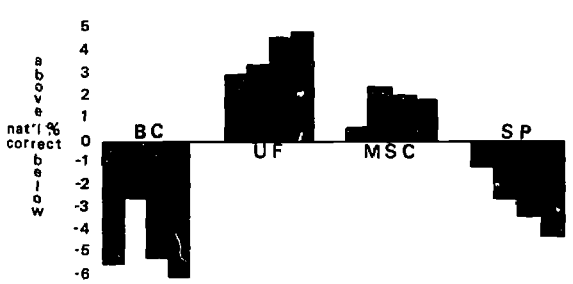
Typical performance of each age in each region or community size on certain classes of exercises, or on all science or writing exercises, is described by the *median effect*. *Median differences* describe typical sex performance at each age.

SOC results—science

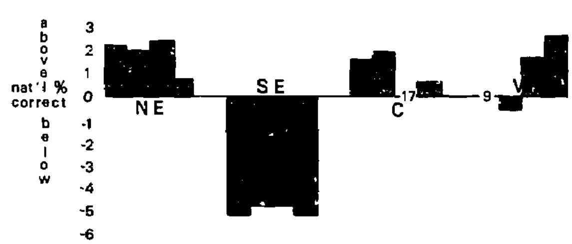


BC—big cities MSC—medium-size cities
UF—urban fringes SP—smaller places

SOC results—writing

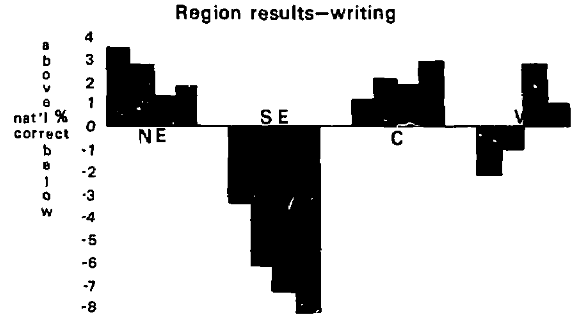


Region results—science



NE—Northeast C—Central
SE—Southeast W—West

Region results—writing



Southeast lowest in both areas

The most consistent regional pattern shown by the science and writing group results is the tendency for the Southeast to perform markedly below the nation as a whole and lower than any other region compared to the nation. On the writing exercises, Southeast success decreases as age increases, with median performance ranging from 3.4 percent below the nation at age 9 to 8.0 percent below at the adult level. On science exercises, Southeast performance is close to the same at all ages, about 5 percent below the nation.

No other regional patterns appear consistently. The Northeast is highest at ages 9 and 13 on writing exercises, but the lead moves to the West at age 17, and the Central region is highest in writing at the adult level. Shifts in leading regional performance also occur in the science results. While the Northeast performs the most successfully in relation to the nation at the three younger age levels, the West leads at the adult level.

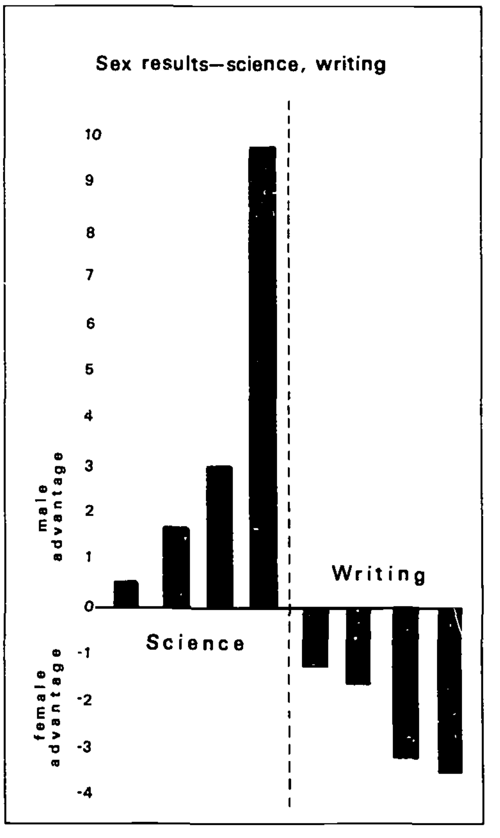
Sex performance reversed

The relative superiority of males and females on all exercises at each age is reversed across the science and writing results: males in general outperform females in science; on the writing exercises, females in general have the advantage.

The superior performance of males in science and females in writing proceeds in the same direction with age, always becoming steadily greater as age increases. For science, the advantage for 9-year-old boys is only 0.5 percent, while for young adults the median shows a male advantage of 9.7 percent. In writing, the advantage in favor of females increases from a median of 1.3 percent for 9s to 3.5 percent for young adults.

Limits on interpretation

The group results released in April reflect the performance of four geographic regions, four community sizes, and the two sexes. They do not reflect the variety of factors that might affect the performance of any particular group. Large fractions of people in certain regions, for example, live in a particular size of community. Thus performance that might be due to size-of-community influences would appear in the latest reports as a regional effect. A large proportion of the parents living in certain community sizes may have



achieved a high level of education. Thus performance that might be due to the socioeducational status of the home would appear in the current group results as a SOC effect.

In future reports, NAEP will provide additional information on some of the variables that might affect performance. In the next science and writing group reports, NAEP will describe performance on the basis of type of community, educational status of the home, and color. Still later reports will consider some interactions among the group variables—say, how big city 17s living in the West perform on science and writing exercises. These kinds of analyses will help to limit the number of possible interpretations of performance patterns, although still not ascribing specific causes.

Discussion and interpretation of National Assessment's results are essential, for they could point to further studies that might be conducted by other researchers to find out why results occur and what steps might be taken to improve performance. NAEP encourages thoughtful examination of its findings and thus has asked four subject matter specialists to review the group results released in April. (The reactions of these reviewers begin on page 6.) Others who look at the group breakdown data will undoubtedly raise additional possibilities concerning the implications NAEP's results might have for American education. ☐

New staff director, new data processing division

Relocation of NAEP offices from Ann Arbor to Denver brings with it changes in the staff directorship and a new division of data processing to handle the project's analysis needs.

Dr. J. Stanley Ahmann, professor of psychology at Colorado State University, will become staff director on July 1, succeeding Dr. Frank B. Womer, who has held that position since 1967. Dr. Womer is returning to his position as professor of education at the University of Michigan.


J. Stanley Ahmann

The appointment was announced by James A. Hazlett, NAEP administrative director, who at the same time noted the establishment of a new division of data processing with ECS. The division will be headed by Dennis Boswell, who has considerable background and experience in operations research and systems theory. He is now a marketing representative with IBM in Denver. Boswell will devote full time during the coming months to developing a data processing staff and investigating the systems required for meeting National Assessment's data handling needs.

In announcing the new staff director appointment, Hazlett said, "We welcome Dr. Ahmann, who comes to the project with a reputation already established in the field of measurement and with experience in university administration and government relations.

"We of course regret Frank's leaving the post of staff director," he continued. "A man of imagination and great energy, he has made a definite contribution to the development of National Assessment."

Dr. Ahmann has an extensive background in educational psychology and has conducted research on the construction and validation of psychological tests, prediction of academic achievement, and evaluation of the effectiveness of educational programs. He joined the faculty at Colorado State University in 1960, where he was professor of psychology and has served in various research-related positions. From 1964 to 1969 he was vice president for academic affairs at the University. Dr. Ahmann was acting director of the Colorado Legislative Committee on Education Beyond High School from 1961 to 1963. From 1951 to 1960 he was on the faculty at Cornell University.

"I am tremendously pleased and flattered," Dr. Ahmann said when asked to comment on his new position. "National Assessment represents to me the largest and most significant evaluation research effort on a national scale. Through its work in the development of assessment materials and the descriptive information it is gathering, it is making an invaluable contribution. In addition," Dr. Ahmann said, "it may very well prove to be a landmark in providing a model for other research efforts."


Frank B. Womer

Dr. Womer has been on leave from his position at the University of Michigan while serving as NAEP staff director. He joined the staff while development of objectives and exercises was still underway, begun by his predecessor, Dr. Jack Merwin, now dean of the school of education at the University of Minnesota.

During Dr. Womer's four-year tenure, much of the developmental work was completed and full-scale data-gathering operations began throughout the United States. □

Reviewers react

Four subject matter specialists were asked to review the science and writing group results and prepare a commentary for this issue of the *Newsletter*. They were asked to speculate about what might be some possible causes underlying the group results, and to consider what implications NAEP's latest reports might have for science and writing education. Highlights of their reactions appear in the article opposite, and in the story that begins on page 10.

Elizabeth Wood is a scientist who recently retired from Bell Telephone Laboratories. She is associate director of the PSNS Project (Physical Science for Nonscience Students), and is a member of the Commission on College Physics and a Fellow of the American Physical Society. Dr. Wood is the author of *Crystals and Light* (Momentum Series) and *Science for the Airplane Passenger* (Houghton Mifflin). She lives in New Providence, N.J.

Richard Merrill is a consultant in secondary curriculum, Mt. Diablo Unified School District, Concord, California. He has taught high school chemistry and been coordinator of secondary science in the Riverside (California) City Schools. Dr. Merrill has also served as executive director of the Chemical Education Material Study. Currently he holds the office of president of the National Science Teachers Association.

Fredelle Maynard is an educational consultant and freelance writer. She has taught English and writing, primarily at the university level, and was a Scholar of the Radcliffe Institute from 1967 to 1969. Among the journals and magazines in which her work has appeared are *Kenyon Review*, *Scholastic Teacher*, *New Republic*, and *Reader's Digest*. Dr. Maynard has just completed *The Blue Remembered Hills*, a collection of short stories and essays.

Walker Gibson is director of the Program in General Rhetoric at the University of Massachusetts, an interdisciplinary effort involving staff from both the English and speech departments. Prior to his appointment with the University of Massachusetts, Dr. Gibson directed freshman English at New York University. His latest books are *Persona* (Random House) and *Tough, Sweet & Stuffy* (Indiana University Press).

Sex results reflect

By Barbara Goodwin

Is it surprising that more boys than girls know that a block struck from one direction will move in the opposite direction? Not necessarily, according to Dr. Richard Merrill. "The commonality between this hypothetical situation and the real situations that boys frequently encounter in football, baseball, soccer, marbles, and a host of other boy-type activities is inescapable."

Is it startling that more young women than young men can write an acceptable letter inviting a prominent citizen to speak to their club or organization? Not really, according to Dr. Elizabeth Wood. "Conversation and letter writing are among the activities more strongly expected of girls than of boys."

Then is the fact that NAEP's results generally show males to "outscience" females and females to "outwrite" males simply what we should have assumed all along? Essentially yes, but this is hardly the way things need to be, the four reviewers of NAEP's group results seemed to suggest.

NAEP, sex research correspond

The sex differences found by NAEP are closely in line with the results of earlier research on sex differences, Dr. Fredelle Maynard pointed out. A number of studies indicate female superiority in skills closely allied to writing performance, she explained: "Girls begin to talk earlier than boys; they combine words into sentences sooner; they articulate more clearly. They have fewer reading problems at all levels, excel throughout the school years in mechanical skills."

And what are the boys doing in the meanwhile, according to the research on sex differences? They're busy excelling in science-related activities, Dr. Maynard explained: "Boys do better than girls on tests of spatial ability, are more able to perceive analytically the individual parts of a visual field, . . . score far higher on tests of mechanical aptitudes (mazes, puzzle boxes, assembly of small objects)."

But male superiority in science-oriented skills and female dominance in communications skills don't necessarily come naturally, Dr. Maynard said. "I think that to some extent these results are culturally determined," she remarked.

cultural expectations, reviewers say

Dr. Wood noted that she knows of no evidence "that males are *born* with better science-learning capacity or poorer writing capacity." She pointed out the unlikelihood that research on sex differences will ever show decisively that boys either are or are not born with better science-related skills than girls, because "such differences could hardly be tested until the children had been subjected to environmental influences for a period of time. . . ."

"You be a boy, you be a girl"

And environmental influences on the two sexes are quite dissimilar, Dr. Wood pointed out. We are accustomed to shops with wares classified as "Boys' Toys" and "Girls' Toys," she explained. But "suppose the shops had divisions labeled 'Toys for Black Children' and 'Toys for White Children,' " she said. "We need only to consider how shocking this would be to appreciate the early segregation of influences on the two sexes."

How different are these influences? Very, according to Dr. Maynard. "In American society," she explained, "girls have always been encouraged to be ladylike (not mess around with frogs, engines, chemistry sets) and boys to be manly (scornful of effeminate pursuits like dancing and poetry)." Dr. Merrill also noted that "girls and boys are encouraged and expected to engage in different kinds of activities. . . ," many of which ". . . would seem to have little rational basis or relationship to the physiological differences between the sexes."

Boyishness, girlishness increase with age

But if environmental influences, which appear to encourage boys to be more science-oriented than girls, are at work at very early ages, doesn't the general lack of a sex difference on the science exercises at the 9-year-old level seem curious? (Boy 9s outperformed girl 9s by only 0.5 percent, a difference that is not statistically significant.) Not necessarily, according to the two science reviewers. Dr. Wood pointed out that the lack of a significant advantage for 9-year-old boys (whose toys "encourage experimentation") ". . . might be due to the counteracting effect of the more rapid development of girls at this age level."

Dr. Merrill offered another reason for the absence of a sex difference in performance at the 9-year-old level. He pointed out that a number of the exercises given at this age, and also at the 13-year-old level, "measure knowledge that is as likely to have been learned out of school as in school." (One exercise asked why it is important to brush teeth; another asked where babies come from.) The advantage that boys might already have in the science classroom would not help them in answering such exercises. And "young girls presumably have at least as much access to television, parental advice, etc., as boys do," Dr. Merrill noted.

Beyond the 9-year-old level, the male science advantage becomes increasingly more obvious—males generally outperform females by 1.7 percent

continued

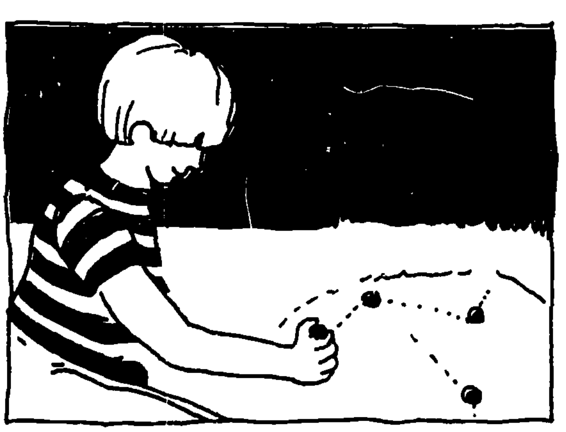
at age 13, 3.0 percent at age 17, and 9.7 percent at the adult level. Why? "A probable interpretation," according to Dr. Wood, "is that the sexually defined roles in society become more widely separated . . . " as age increases.

Dr. Merrill pointed out that differences in recreational activities engaged in by the two sexes might well have affected some of the science results at the older age levels. Just as the block exercise given to 9s related especially well to boys' experience, he said, "some of the apparatus exercises on which male 13s and 17s enjoyed the greatest advantage may have similar relationships to masculine nonacademic activities." And Dr. Wood pointed out that at the higher levels "recreational activities and physical-performance equipment" provided to the two sexes "become even more disparate" than at the younger ages.

Motivations become more sex-linked

Dr. Wood also speculated that "the motivation to become informed about such matters as are covered by the science exercises" becomes more divergent as boys and girls assume their sexually defined roles. She noted that such a hypothesis is consistent with the results at the higher ages, which show "female superiority in responding to exercises related to human reproduction, and male superiority in exercises related to experiments in physics."

Social and cultural expectations must surely underlie the unequal exposure of the sexes to science in high school, according to Dr. Merrill. He pointed out that "at the high school and college levels more boys take more science or science-related courses than girls do, high school biology excepted. Disproportionate male enrollment is especially characteristic of such courses as chemistry, physics, earth sciences, industrial arts, electronics, and engineering."



What is the ultimate effect of sex role expectations, both for science and for the sexes? ". . . It is almost surely true," Dr. Merrill said, "that more women than men who would be capable of creative contributions to science, or whose lives would be greatly enriched by further study of science, are diverted from these possibilities by traditional sex role expectations. . . . Perhaps the schools should be more active in making girls aware that these expectations exist and are molding their lives, and that they are not immutable."

English study—the "lady-oriented approach"

And just as traditional sex role expectations limit the potentialities of girls in science, they may restrict the achievement of boys in writing, Dr. Maynard's comments seemed to suggest. "Cast your eye over a list of proposed essay topics in a standard high school rhetoric," she invited: "My Favorite Fictional Character, Good and Bad Study Habits, Educational TV, Family Outings. . . . How many of these would stimulate a boy whose consuming passion is rocketry?"

"Women's Libbers may complain that school texts glorify men," Dr. Maynard acknowledged, "but composition programs generally favor girls." One of the most important determiners of the boys' general disadvantage on NAEP's writing exercises, according to Dr. Maynard, is "the lady-oriented approach of English studies. "Boys," she said, "are not *expected* to excel in English. . . ."

Girls try to please

Since females outperform males at every age on the writing exercises in general, the overall results seem consistent with Dr. Maynard's speculations. The results that appear when only NAEP's essay exercises are examined, however, seem to defy generalizations about the feminine approach of English studies. The results show that the two sexes do about the same on essays—females outperform males on 8 such exercises, and males outperform females on 8. None of the advantages are statistically significant, and the combined results on all 16 exercises given at NAEP's four ages indicate that there is essentially no sex difference in essay performance.

Why not, if male performance is hampered by the fact that boys aren't expected to excel in English? Because, both writing reviewers noted, society has encouraged a sex-linked difference in approach that affects writing performance. On nonessay performance exercises, this difference works to the girls' advantage, Dr. Gibson and Dr. Maynard suggested; on essay exercises, it does not.

Dr. Gibson was not surprised that girls generally outdo boys on nonessay exercises that require completion of writing tasks (such as filling out the parts of an envelope or writing an invitation to a class play). "Is this that notorious willingness to please . . . that invariably infects girls more than boys?" he asked. "Girls try hard to get good marks; they try to give you your right answers," Dr. Gibson suggested. "Boys . . . get their kicks in more violent ways."

Dr. Maynard appeared to agree. "Girls diagram sentences patiently, make fewer spelling errors; they wish to please. The boys, by and large an untidy lot, fight exercises and drill."

But when it comes to essays, where there is no right answer, the "girl-approach" doesn't necessarily work, the writing reviewers explained. "Give both sexes an essay to write, in which we may hope the writers get a little involved beyond the production of right answers, and the performance evens out," Dr. Gibson noted.

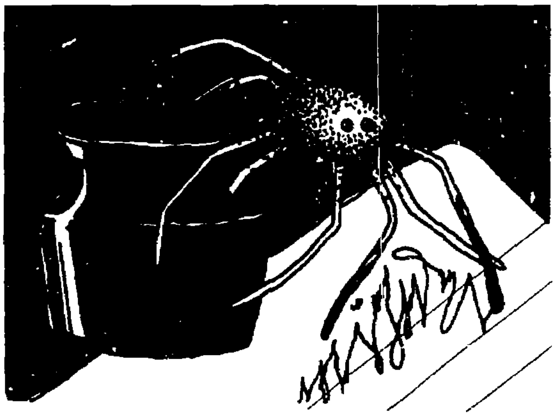
Why? Because "the boys are more daring," Dr. Maynard suggested. "Where the typical girl-theme joins one tidy notion to another like links in a chain, the typical boy-theme is a plunge or an explosion."

Dr. Maynard illustrated by recounting her experience as a College Board essay scorer. "There's a special variety of good-girl essay that always rates 2 on the College Board 1-4 scale: it's written in a neat round hand (often with little circles dotting the i's), its emotional tone is palest pink, it has lots of paragraphs . . . and few ideas. And there's a special variety of boy paper, inscribed apparently by a spider that's just crawled out of an inkwell. Sometimes it's funny, sometimes it simply communicates a flash of intelligence; often it's chaotic. And you end up–in spite of spelling errors, wild punctuation–giving it a 3. Because it's *alive.*"

Science, writing in separate boxes

How can the energy and inventiveness of boys be channeled into improved overall writing performance? And how can girls be encouraged to be more independent? Part of the answer might have to do with reducing what Dr. Maynard called the "assumed dichotomy" between science and writing that "runs through American schools. . . . Except perhaps in the early grades," she said, "science and writing are kept in separate boxes. The young physicist, the young engineer, quite naturally concludes that what happens in English class has little importance for him."

His conclusion is "natural," Dr. Maynard seemed to suggest, only because science and writing educa-



tion make it appear so, not because these two subjects are vastly different. "The qualities that make a good scientist are the very qualities we value in a writer: a sharp eye, an open mind, a drive for order, a respect for truth."

Scientific art, artful science

Educators could capitalize on the similarities between writing and science, Dr. Maynard pointed out. "English teachers could help boys see the value of describing accurately and communicating the results of observation (as, surely, science teachers might show girls the power of analytic reasoning). They could give boys a chance to write more often about subjects that deeply, passionately interest them. And curriculum planners could see to it that boys are exposed not only to good science fiction, which has made some headway in school anthologies, but also to serious scientific writing of a high literary quality–T. H. Huxley, Darwin, Gilbert White, Konrad Lorenz."

Elwyn Richardson's *In the Early World,* which describes the author's experiences as a New Zealand teacher, shows how science and writing can complement each other, Dr. Maynard explained. Richardson described how his students explored the world around them and then communicated their discoveries in ordered form–how a wasp's nest led to a meticulously kept journal of observations, which in turn led to wasp stories, wasp poems, wasp paintings. . . . And so "science became writing and writing science," Dr. Maynard explained.

Teachers could "assist every child to employ . . . his natural strengths, whether these are predominantly artistic or predominantly scientific," Dr. Maynard concluded. "But to achieve this objective," she acknowledged, education needs "gifted teachers, small classes–and time. It is not possible in situations where a harried teacher meets 5 classes daily, with 35 or 40 students in each class." □

Reviewers react

Dollars = environment = region

The regional results in both science and writing show that Northeast performance on NAEP's exercises is typically above that of the nation as a whole at all four ages, while Southeast performance is below at all four ages; Central and West performances generally fall in between. The size-of-community (SOC) results show all four ages in urban fringes to perform above the nation as a whole on NAEP's science and writing exercises, while all four ages in big cities generally perform below; medium-size cities and smaller places fall in between, the former performing slightly above the nation and the latter, slightly below. (The region and SOC performance patterns are illustrated in the graphs on page 3.)

What explains NAEP's results? Why does the Northeast do well and the Southeast do poorly? Why do urban fringe residents outperform the nation, while people in big cities perform below the national average? And why do these results appear in both science and writing? The reviewers offered a number of possible explanations, many of which suggest, as Dr. Merrill noted in discussing the similarity of science and writing results, "general educational, social, or economic bases rather than causes specific to science or writing education."

What happens in and out of school

Dr. Wood pointed out that performance on NAEP's exercises depends on essentially two factors—potentialities with which an individual is born, and "influences that modify him after birth, both outside of school and in school."

The environmental factors that influence performance are numerous, Dr. Wood pointed out. Among the out-of-school factors she cited are expectations—including those of relatives, neighbors, companions, and self—health care, the physical environment (including the presence or absence of books in the home), incidental and formal training (such as the transmittal of customs and help with lessons), and the educational level of relatives. Some of the in-school influences Dr. Wood mentioned are the physical environment, including the physical plant of the school; the educational background and training of teachers and administrators; and instruction, both formal and informal.

Such environmental influences rarely work in isolation, according to Dr. Wood. She pointed out that "poor health, for example, could lead to below-average self-expectation." Dr. Wood noted that all the factors she mentioned "and other influences interact in a complex way."

Differences in Northeast, Southeast schools

What do NAEP's regional results suggest about the environmental factors that influence performance? Dr. Wood quoted NAEP's science report: "On certain exercises that might be answered on the basis of out-of-school experience, the Southeast performs as well as or better than the rest of the country." This suggests, she said, "that the in-school experiences of an individual in the Southeastern part of the country do not provide him with knowledge, skills, and attitudes matched to the performance expectations of NAEP."

Both Dr. Merrill and Dr. Maynard acknowledged the importance of environmental factors, and their comments suggested reasons why the in-school influences might be quite different in the Northeast and Southeast. Dr. Merrill noted that per-pupil financial support of education is low in the Southeast, and speculated that this fact might well underlie the poor performance of this region. "I know of no peculiarities in the science curricula or typical teaching methods employed in the Southeast that would account for the overall results," he said, "save for limitations imposed by lack of adequate financial support."

Dr. Maynard, too, suggested that the regional results reflect in part the amount of money spent for education. She cited figures comparing the Northeast and Southeast on the basis of per capita pupil expenditures (as of last year 9 of 12 Northeastern states were above the national average on such spending while all the Southeastern states were below); teacher salaries (two-thirds of the Northeastern states were above the national average last year while all the Southeastern states were below); and pupil-teacher ratios (in 1969 11 of 12 Northeastern states had fewer pupils per class than the national average while all the Southeastern states had more).

"These are gross indicators," Dr. Maynard acknowledged. "We all know that a high-paid teacher in Connecticut is not necessarily better

and size-of-community results?

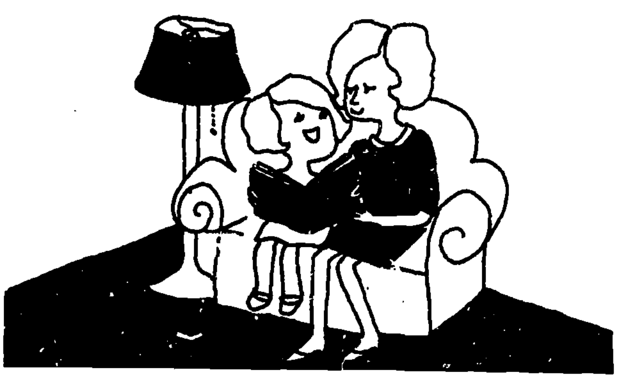
than an underpaid teacher in Kentucky." But, all things being equal, she added, "the best teachers go where the money is."

How does the amount of money available for education influence the in-school influences cited by Dr. Wood? Dr. Merrill mentioned several characteristics of the in-school environment that appear to be directly related to the amount of money spent for education, such as the length of the school year, facilities and equipment available, and teacher preparation. And Dr. Maynard pointed out that "children have a marked advantage in communities where education is valued (supported in the most concrete way, by adequate funds) and in schools where classes are small, teachers able and well trained."

What influences the home influences

Economics also seemed to be at the root of comments made by Dr. Maynard and Dr. Merrill as they discussed factors related to the out-of-school environment in NAEP's four regions. Both reviewers cited the low per capita income of the South as a possible cause of this region's below-national performance.

Dr. Maynard explained how income can ultimately affect educational performance. "A child from a low income family is educationally disadvantaged before ever he leaves for school," she said. "Unhappily for the American ideal, it is not true that the schools can correct for economic inequality. Children of well-to-do parents enjoy a continuing advantage: their parents are likely to have had more varied experience, command a broader vocabulary, own more books .... As the



Coleman report observed some years ago, 'the school appears unable to exert independent influences or to make achievement levels less dependent on the child's background.' "

Dr. Merrill appeared to agree that causes related to income may underlie the results, speculating that considerations such as nutrition and the average age of leaving school might be possible secondary causes stemming from economic bases.

The many secondary influences cited by Dr. Merrill and Dr. Maynard—nutrition, books in the home, number of pupils in the classroom, teacher salaries—seem to underscore what Dr. Wood pointed out earlier as the complex way in which environmental factors interact to determine each individual's "fabric of knowledge, skills, and attitudes."

Still different factors were mentioned by the reviewers as possible explanations for the results in the Central and West regions. Dr. Wood noted that performance in the Central region (Central 9s and 13s do better than the nation as a whole while Central 17s and adults do not) is exactly the reverse of West performance. "Do the superior performers migrate westward out of the Central region (perhaps to go to college, and stay on after college)," she asked, "or is there something in western living that makes the West's 17s and young adults more knowledgeable than its younger people compared to the rest of the nation?"

Dr. Merrill considered similar causes. He speculated that migration might explain the drop in science performance at the adult level in the Northeast (see the graphs of regional results on page 3) and the comparably higher performance in the West. The results for West adults might, too, reflect "the highly accessible system of public higher education in California," he suggested. But he also speculated that the average-raising effects in the Northeast, Central, and West regions "may, in the main, be due to the lesser prevalence of the circumstances that limit performance in the Southeast."

Urban fringes beckon

Many of the reviewers' comments suggesting causes for the size-of-community results found by NAEP again centered on differences in the in- and out-of-school environments. And, again, the causes mentioned seem ultimately to be mainly economic.

continued

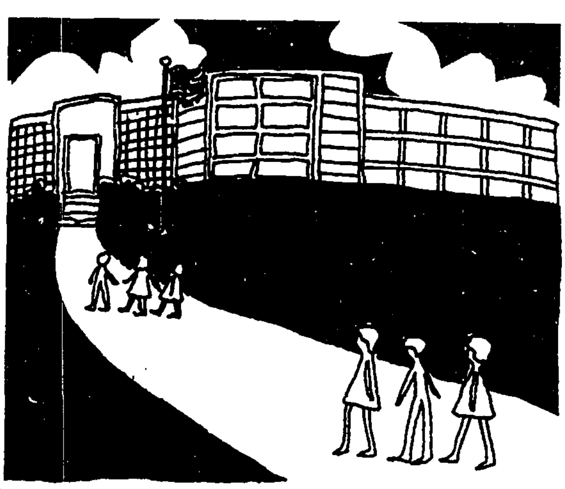
Why do people in urban fringes outperform the three other SOC groups compared to the nation at every age in both science and writing? Primarily because of the attractions of urban fringe living, both in and out of school, Dr. Maynard and Dr. Merrill seemed to suggest.

Dr. Maynard speculated that schools play a major role in the desire to move from the city. "People who move out of the city are generally better off, better educated, more highly motivated, and more concerned with the schools. Often schools are the reason for their migration to the urban fringe."

The children of such families have several important advantages, Dr. Maynard explained. They "benefit from support and encouragement at home, and from association with a peer group similarly motivated." She pointed out that studies have shown that "the strongest educative force in the school" is "the student body."

(Dr. Wood, discussing performance modifiers in general rather than in relation to urban fringe residents, also noted the importance of peer groups and parental encouragement. "Expectations of customary behavior may vary from school to school," she pointed out; "there are schools in which a student who tries to succeed at his studies is mocked by his companions. Both teachers and parents may communicate to young people, often implicitly, expectations ranging from admiring aspirations of success to contemptuous anticipation of failure.")

Dr. Merrill pointed out a number of more concrete advantages offered by urban fringe schools. "Unlike rural areas," he explained, "urban fringes and medium-size cities have schools of a size such that a rich and varied curriculum can be offered economically, without the drawbacks of impersonal, paralyzing size that may beset big city schools and school systems." Curriculum innovations are usually more rapidly and widely diffused in these types of communities, he added. And "urban fringe areas probably get to choose from among more qualified applicants than big cities, even when the cities pay more," he speculated. "Teachers are people, too," he remarked.



Dr. Maynard echoed Dr. Merrill's reminder. "Where would *you* rather teach," she asked, "in Scarsdale or Watts?"

What they do and w

Other than for a school assignment, have you ever written a poem? short story? play? article for a newspaper? words for a song? If you've taken a trip during the last 12 months, have you done any writing about it, such as filling out a postcard? keeping a diary? making notes about some of the things you saw? writing a report after you got home?

These are two of a number of exercises that were administered by NAEP to gain information about people's attitudes toward writing. And the results for exercises asking for such self-reports of writing activity are generally quite different from those for exercises requiring actual writing performance.

NAEP found that groups that perform well on "doing" exercises (filling out an application blank, writing a mail-order letter) often do not do as well on exercises asking for self-reports of writing activity. The median performance of 17s in urban fringes, for example, is 6.5 percent above the nation as a whole on "doing" exercises, but on self-report questions it is only 2.5 percent above the nation.

In contrast, NAEP found that groups who typically perform below the nation as a whole on "doing" exercises don't do as poorly on self-report questions. Thus the median performance of Southeast 13s is 8.0 percent below the nation on "doing" exercises but only 0.5 percent below the country as a whole on self-report questions.

Comparisons between the results for performance and self-report exercises show that while the groups assessed by NAEP may vary considerably in terms of writing quality, they don't perform very differently when it comes to reported writing quantity. Do the results mean that one group in fact writes about as much as

Problems varied in other SOC groups

But attracting good teachers is a problem for smaller places as well as for big cities, Dr. Maynard noted. "Unmarried teachers, particularly bright young graduates, do not head for rural Alabama. Or if they do, they don't stay; small towns and rural districts suffer from a high rate of teacher turnover."

And there are other disadvantages at work in big cities and smaller places, she pointed out. What are the problems in big cities? "Strikes, riots, drugs, violence, poverty . . . and never enough funds. Many big cities get less than their fair share of state money," Dr. Maynard remarked.

Funds for education are often a critical problem in small places, too, she explained. "In states like New Hampshire," she pointed out, "where small-town schools depend almost entirely on local property tax, funds are scarce and programs shortchanged."

But small-town performance might be affected by still another factor, Dr. Maynard speculated. Rural life frequently fails to "offer intellectual stimulation at the ages where such stimulation matters most," she said. "Many small-town youngsters graduate from high school without ever having seen a professional play or an opera or a ballet; they have never been to a symphony concert or an art gallery or a museum or a real library."

Dr. Merrill agreed that the influence of out-of-school activities is an important factor in performance. He speculated that "the out-of-school activities available to both children and adults may be more varied in the urban fringes and medium-size cities. These and other factors contribute to an 'educational climate' that could well account for the observed differences in results among the various sizes of community," he suggested.

More information needed

The reviewers were asked to speculate about some *possible* explanations for the group performances described by NAEP, not to assign specific causes to specific results. As Dr. Wood's comments indicated, many considerations that might be relevant in a particular group's performance are not illuminated by the latest reports.

Dr. Wood cited several examples that illustrate the need for more information about the composition of NAEP's groups. While suburban schools "might be expected to do better than big cities with their crowded ghettos or rural areas with their small, isolated schools," she explained, it should be remembered that NAEP's urban fringe category includes both "heavily industrialized fringe zones" and "affluent residential suburbs." Also, she pointed out, "big cities include some of our most advantaged population as well as our most disadvantaged. . . ."

Future NAEP reports are expected to shed some light on such subcategories. In the next science and

continued

hat they say they do

another? The two writing reviewers suggested a less flattering possibility.

Dr. Gibson speculated that a willingness to please the teacher or test-giver might explain a group's better performance on self-report exercises than on exercises requiring actual writing. "Asked to report *rather than perform*, respondents from the Southeast are able to come up with satisfactory answers. Who can blame them?" Dr. Gibson asked. "If I know that I've been disappointing in performance, can I not compensate a little by showing that I have the right 'attitude'?"

Dr. Maynard took a similar view of the discrepancy between low "doing" performance and higher self-report performance. ". . . I know that test-takers remain anonymous, that they anticipate no consequences whatsoever as a result of failure or nonperformance," she acknowledged. But "this fact doesn't alter a fundamental truth of the test-taking experience: that it is always diminishing, if not humiliating, to know that one is doing badly. A severely disadvantaged writer can't order sea horses or even fill out that application blank. But, by heaven, he can make check marks—and he does. Yes, he reads books. Also business letters, directions or instructions, magazines, newspapers, personal letters, and recipes. You name it, he reads it. When tripping, he floods the mails with postcards and thank-you notes. . . ."

Dr. Gibson noted that differences indicating that certain groups report better than they perform "don't seem to be overpowering. . . ." And if an explanation is needed, he said, ". . . we could reasonably call it a function of insecurity. . . . There must be a good deal of sheer human insecurity lurking in many of these statistics."

writing group reports, results will be presented for type of community (such as impoverished inner city and affluent suburb), educational level of the parents of respondents, and color (black, white, and other). And in still later analyses NAEP will describe some interactions–say, how urban fringe 17s in the Southeast perform on science and writing exercises. Such reports may narrow the number of possible factors to be considered in speculating about performance patterns.

Money = success?

The group results currently available permit only broad speculation. And the underlying factor behind many of the reviewers' comments seems to be largely economic–how income influences the home environment (which in turn influences school performance), and how per pupil expenditures influence the quality and scope of education in the classroom.

Dr. Gibson found none of NAEP's regional and SOC results surprising. "Certainly no school system in the rural South needs to feel any more guilty than usual as a result of the figures; certainly no Westchester system needs to feel any more self-congratulatory than normal," he said. "For what are we really talking about when we make such comparisons?" he asked. "We are talking about money. . . . When we make assessments like these, we are not measuring the efficiency of school systems–we are measuring ways of life, different scales of life styles, mostly economic at base." *B.G.*

NAEP slide show available

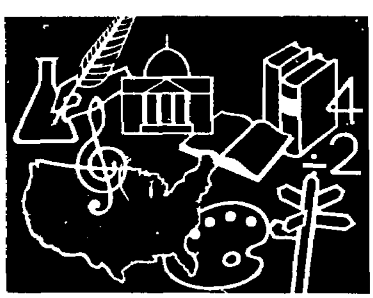
Since it was announced in the November-December *Newsletter*, the National Assessment slide show has been viewed by more than 50 organizations. The show, which provides a concise description of NAEP's history and goals and of how assessment activities are carried out, remains available for use by the general public.

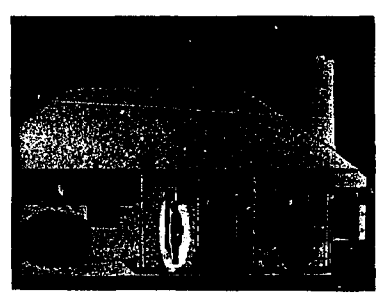
The production is approximately 20 minutes long. The tape can be played on any half-track recorder that advances tapes at 7-1/2 inches per second. A Kodak Carousel projector is required; a Kodak Carousel Model 1 programmer, although not essential, will permit automatic advancement of slides. (A series of signals is provided on the tape for either automatic or manual advancement.)

The slide show is available at no fee except for a small postal charge. Requests should be sent to:

National Assessment Information Services
300 Lincoln Tower
1860 Lincoln Street
Denver, Colorado 80203

Please make requests as far in advance of the required date as possible so that the slide show can be forwarded on schedule.





NSTA hosts NAEP

Science educators and scientists around the nation had an opportunity to become better acquainted with National Assessment when project personnel participated in the 19th annual convention of the National Science Teachers Association (NSTA), held on March 26-30 in Washington, D.C. NAEP presented two sessions at the convention, which was attended by some 7,000 NSTA members who met to discuss science education decision-making.

Two reports follow. The first describes the March 27 session, which focused on NAEP's revised science objectives and the views of Dr. Edward E. David, Jr., who discussed national objectives for science education. The second presents the reactions of five reviewers who examined NAEP's national science results.

Defining objectives for science education

Staff director Frank B. Womer led NAEP's Saturday session at the NSTA convention. He provided the audience with a brief introduction to National Assessment, and also pointed out the contributions of science to NAEP's overall design.

Dr. Womer explained that science, since it was among the first three subject areas to be assessed by NAEP, provided valuable feedback on the effectiveness of techniques used to administer exercises on a national scale. Science will also contribute to the development of NAEP's analytical techniques, Dr. Womer pointed out, because it is the first area in which the project will do complete reporting of results. And science plays an important role in NAEP's procedures for defining educational objectives, he explained, because it is the first subject area to be redeveloped for a second assessment.

Why redevelopment?

Dr. Marjorie Barnes, a National Assessment science consultant, next discussed some of the details involved in readying science for reassessment in 1972-73. The original science objectives, which served as a basis for exercises administered during the first science assessment, were developed in 1965, Dr. Barnes pointed out. To determine whether they were still current, and thus could guide the development of exercises for the second science assessment, the original objectives were examined by a number of specialists in the summer of 1969, she explained. The reviewers were asked to examine the original objectives from the point of view of current developments in science and education. Do the original objectives reflect what the schools are teaching? Is their content valid and relevant? Do they accurately reflect the contributions of science? Are they written in the form currently acceptable for behavioral objectives?

A number of recommendations were offered at this time, and additional inputs were later sought from other reviewers, among them subject matter specialists, educators, lay citizens, and students.

The revised objectives are now nearly complete, and Dr. Barnes discussed some of the changes that were made as a result of reexamination. One of the differences she mentioned was that the cognitive behaviors included in the revised objectives are clearly categorized on the basis of whether they focus on *knowing* something, or on *doing* something with what is known. A second difference is that the revised objectives are stated in more behavioral terms than was the case with the original set. Dr. Barnes pointed out that behavioral statements make it possible to observe more readily whether or not a person is able to meet a given objective.

David gives views on national objectives

Next on the Saturday program was Edward E. David, Jr., science advisor to President Nixon and director of the Office of Science and Technology. Dr. David was invited by National Assessment to discuss his views on national objectives for science education.

Much of Dr. David's talk focused on the gap he finds between what the public expects from science and technology and what these fields can actually produce. "The public's expectations," he remarked, "are quite unrealistic."

Dr. David illustrated by pointing to the public reasoning that he sees reflected in newspapers and among his lay acquaintances—namely, that if scientists and technicians can send a man to the moon,

continued

Edward E. David, Jr.

they can clean up the environment, develop mass transit systems, increase the availability of health care, and so on. "The public mind has been nurtured on the remarkable accomplishments of science," he explained. Dr. David remarked that the public, in general, "feels that scientists and engineers can accomplish literally anything if they put their minds to it."

Such reasoning is of course fallacious, he indicated. And it has frequently led citizens to become disillusioned with scientists and technicians when they at last discover that science is not omnipotent. Dr. David believes this disillusionment points to a clear and important goal for science teaching —"the education of the general public as to what they can reasonably expect from science and scientists."

Constraints on science, technology

What is involved in this education of the general public? The public needs to become better informed about some of the basic limitations on science and technology, Dr. David suggested.

First, the public must be made better aware that technology cannot violate the laws of nature. The idea of building a perpetual motion machine is frequently proposed, Dr. David said, "despite the fact that such a notion violates the first law of thermodynamics."

A second constraint about which Dr. David believes the public should be better informed involves the limitations imposed on science and technology by the state of the art. "It is theoretically possible to transmit literally thousands of television programs on a single beam of lazer light," he said, "but a practical system of this sort is beyond our present technology." The public must come to understand, he added, that "what is socially desirable may not be technically possible because it is beyond the state of the art."

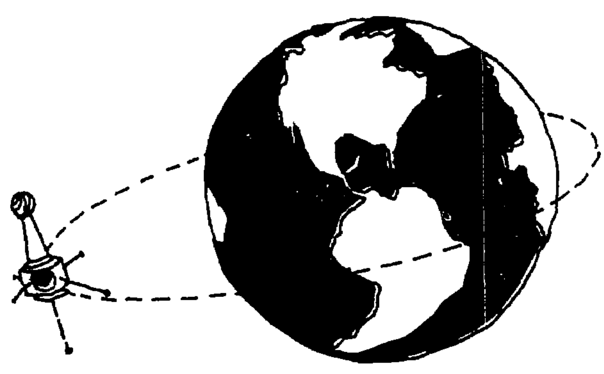
Economic, political, and legal considerations were also cited as not infrequent constraints on the accomplishments of science and technology. Dr. David mentioned computer-assisted instruction (CAI) as an example. "CAI could have some important uses in education today," he said, "and yet most observers who have examined it agree that it is too expensive except for some very special applications." The public must gain greater understanding, he said, that "the benefits achieved through technology must be commensurate with the resources that have been expended."

Increase public's understanding

Such constraints are obvious to science educators, Dr. David acknowledged, "but they are too often ignored by the public." In his view, "the most important objective of science education is to make future generations cognizant of the real nature of the scientific and technological enterprise."

Early in his talk, Dr. David made it clear that his viewpoint was not that of a science educator, but rather of a scientist. He invited the audience to interpolate his remarks so that they could be made relevant to National Assessment.

Dr. Barnes had mentioned previously that the reviewers of NAEP's original science objectives expressed concern about the scientific enterprise. They felt, she had indicated, that the original objectives placed too little emphasis on the contri-



butions of science and technology to society. As a result, the revised objectives give increased attention to the nature of the scientific enterprise.

A number of statements in the revised objectives seem to reflect the understandings Dr. David believes are essential. One subobjective, for example, focuses directly on several of the constraints he itemized: "know that scientific and technological developments depend on the prevailing cultural, economic, political, and social conditions." Another subobjective appears closely related to Dr. David's remarks about limitations imposed on science and technology by the state of the art. It emphasizes the importance of historical perspective in understanding present-day science and technology. (An example of such historical perspective included in the objectives is awareness of the fact that it has taken about 300 years to implement Newton's principles of putting a satellite into orbit.)

Dr. David admitted the difficulty of evaluating a general objective which focuses on increasing public awareness of what science and technology can and cannot do. It is "perhaps not even measurable," he said, "for it involves the attitudes of people toward science and technology." (National Assessment experienced considerable difficulty in measuring attitudes, as noted by the reviewers whose reactions follow.) But marketing specialists and others are becoming increasingly successful, he added, expressing his belief that "it will be possible in future years to measure much more subtle aspects of education than we do now." In the meantime, he said, "we should not constrain our educational system to only those objectives that we can measure." □

Reports, new publications

Copies of the National Assessment reports released at the July and November meetings of the Education Commission of the States are available. The following prices have been established to cover printing costs:

Science National Results–$1.75
Science National Summary–$0.35
Science National Commentary–$0.50
Citizenship National Results–$1.25
Citizenship National Commentary–$0.40
Writing National Results–$1.50.

(Each commentary includes the reactions of five subject matter specialists asked to review National Assessment's results.)

Publications are available from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

Checks or money orders should be made out to the Superintendent of Documents.

Note: Science and writing group results–for region, size of community, and sex–have not yet been printed in quantity. Details for ordering these reports will be announced as soon as they become available.

A new objectives brochure and two new reprints have been added to National Assessment's publications:

Career and Occupational Development Objectives, National Assessment, Ann Arbor, Michigan;

"National Assessment in Mathematics," Dale I. Foreman and William A. Mehrens, reprinted from *The Mathematics Teacher*, March, 1971;

"National Assessment: An Information Gathering and Information Dissemination Project," Eleanor L. Norris, reprinted from *Education*, April-May, 1971.

The reprinted articles are available at no charge; the objectives developed for career and occupational development cost $1 per copy. Please address requests to:

National Assessment Publications
Room 201A Huron Towers
2222 Fuller Road
Ann Arbor, Michigan 48105

A listing of all publications available from National Assessment will be sent free of charge upon request.

Specialists review national science

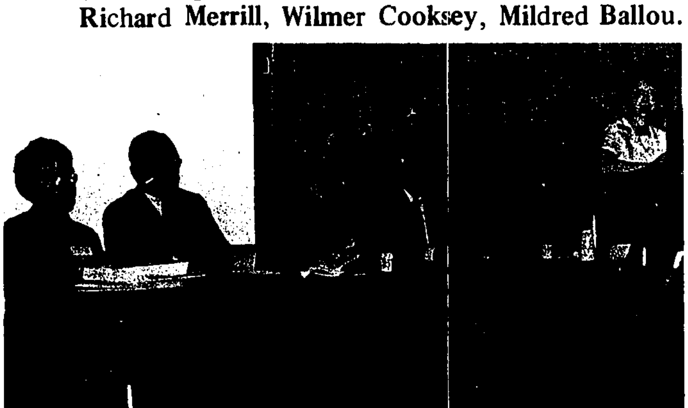
On Monday, March 29, NSTA members gathered to hear five reviewers discuss what implications NAEP's 1969-70 science assessment might have for science education. Group results for region, size of community, and sex were not available for presentation at the NSTA convention. Instead, the focus was on the national science results, which had been released by NAEP in July, 1970.

The reviewers–a classroom teacher, a science curriculum specialist, two science teacher educators, and a retired scientist–had prepared reactions when the national science results were first released. For the NSTA convention, they were asked to comment further on the first science assessment. How might National Assessment's findings affect the teaching of science in the classroom? What influence might National Assessment have on the preparation of science teachers? In which areas of science education do the national results indicate strengths and weaknesses?

Don't discount importance of facts

Mildred Ballou, professor of elementary science education at Ball State University, led the Monday session. Many of Dr. Ballou's comments centered on the results for Objective 1 exercises, which deal with knowing facts and principles of science. While she acknowledged the importance of NAEP's other objectives, which focus on science processes, the investigative nature of science, and attitudes about

(left to right) Elizabeth Wood, Stanley Williamson, Richard Merrill, Wilmer Cooksey, Mildred Ballou.



science and scientists, Dr. Ballou appeared particularly pleased with National Assessment's efforts to assess Objective 1.

As science educators, Dr. Ballou told the NSTA audience, "we have become so interested in processes that we have tended to say that facts are not important." Processes are of course essential, Dr. Ballou pointed out, but so too are facts. "No one can think in a vacuum. One can't even get very far in the inquiry process without having some facts and information."

The distinction that should be kept in mind by science educators, both as they teach and as they look at National Assessment's results for Objective 1 exercises, Dr. Ballou suggested, is the difference between saying "facts tend to be meaningless" and "facts *in isolation* tend to be meaningless."

In illustrating this distinction, Dr. Ballou pointed to an exercise that asked 9-year-olds to choose from among fat, protein, salt, starch, and sugar the item most important in building muscle. The correct answer, protein, was selected by 85 percent of the 9s. Dr. Ballou appeared pleased that so many 9s know what protein is. But such a result does not imply that 9-year-olds, if given a choice, would select or be able to recognize adequate amounts of protein in the diet, she noted. "Knowing and doing are two quite different things." It is essential to teach facts, Dr. Ballou suggested, but this must be done in a way that "enables students to integrate what they know into their life styles."

Dr. Ballou expressed her dismay over the lack of knowledge shown by young people on Objective 1 exercises dealing with human birth and reproduction. She cited several exercises whose results she found very disappointing. One called on 17s to identify the function of the placenta as that of carrying nourishment to the baby; 41 percent responded correctly. Another asked 17s to indicate knowledge that on the average in human females, the egg is released 14 days after menstruation begins. Only 29 percent responded correctly.

In commenting on these results, Dr. Ballou cited statistics which indicate that 790 illegitimate children are born every 24 hours in the U.S., and that of these, approximately 47 percent are born to girls between the ages of 12 and 17. "With today's emphasis on population control, and an increase of

esults at NSTA annual convention

illegitimate births, facts in the area of human reproduction have tremendous personal and social significance," she noted.

What are the implications of the first science assessment for science education? "National Assessment has caused us to take a hard look at what we're doing in science," said Dr. Ballou, "and perhaps it has raised some questions about what ought to be taught in science."

Physical sciences unappealing

Wilmer Cooksey, chemistry teacher at Woodrow Wilson High School in Washington, D.C., also expressed alarm about some of the results for Objective 1 items. He was especially concerned about several exercises given to 17s. "The 17-year-olds demonstrated some common misconceptions," Mr. Cooksey said, pointing to a number of exercises in illustration.

One exercise asked 17s to identify iron as the chief element in metal cans. Only 3 percent did so. (Tin was the response given by 93 percent of the 17s.) Another exercise listed several characteristics of birds and asked that the one unique to them be identified. The correct answer, a body covering of feathers, was chosen by 52 percent (27 percent of the 17s selected the ability to fly as the unique characteristic). A third exercise asked 17s to identify the effect of adding table salt to water as that of causing the water to freeze at a lower temperature. The correct answer was given by 36 percent of the 17s (28 percent thought the effect would be a more rapid rate of evaporation).

The exercises dealing with the composition of metal cans and the effect of mixing salt and water were among 36 exercises given to 17s which dealt with physical science. Mr. Cooksey cited several other physical science exercises whose results he found disappointing. One presented a diagram of an electrical circuit and asked for the number of ohms of resistance indicated by readings given for a voltmeter and ammeter. The correct answer was selected by only 25 percent of the 17s, while nearly half (48 percent) chose the I-don't-know response. Another exercise asked 17s to identify what is shown by experiments in which atomic particles were shot at metal foil. The correct answer, that atomic nuclei are more dense than the rest of the atom, was given by 18 percent; 54 percent chose the I-don't-know response category.

Mr. Cooksey interpreted the results of many of the physical science exercises given to 17s as "an indictment on us science teachers—we are not encouraging youngsters to take physical sciences." He estimated that only about 20 percent of the nation's high school population is enrolled in physical science courses. "It is possible in our high

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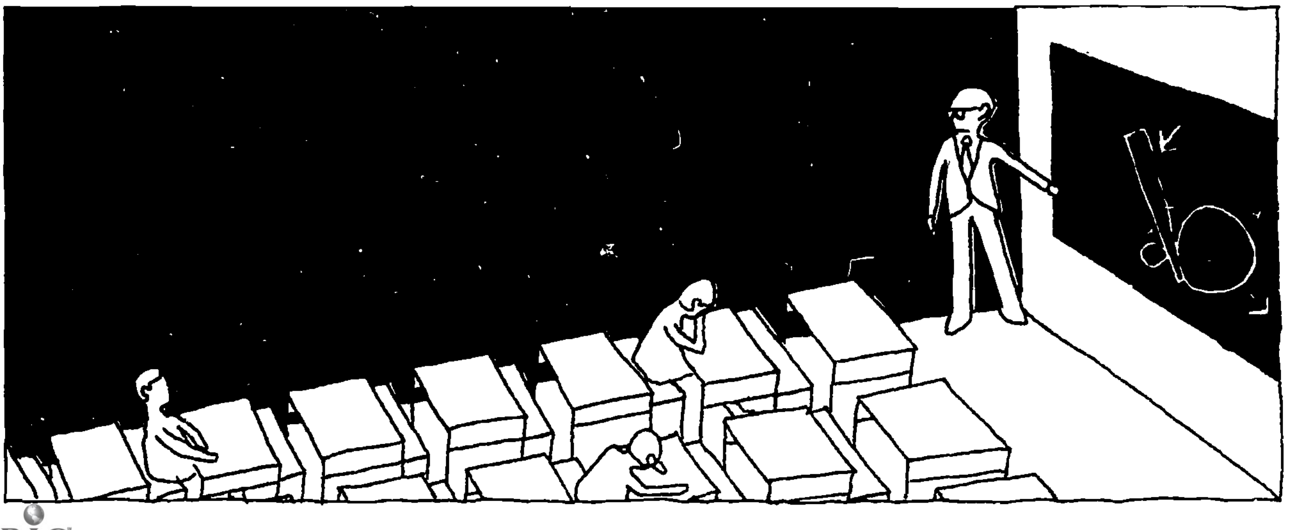
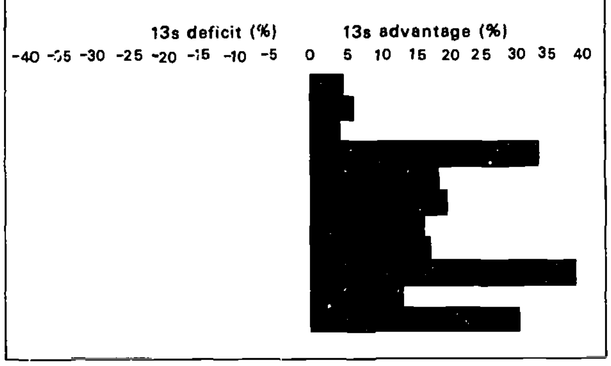
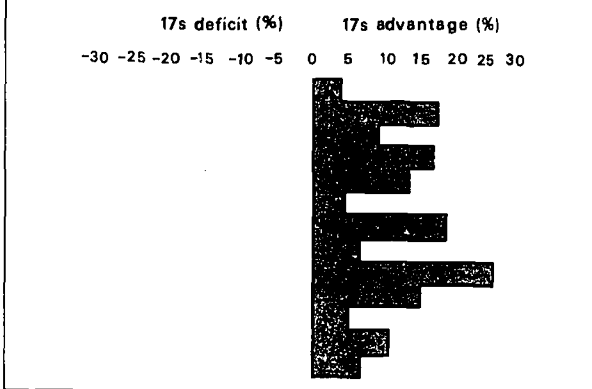


13s compared to 9s on overlapping exercises—objective 1
(11 exercises)



17s compared to 13s on overlapping exercises—objective 1
(13 exercises)



schools today," he added, "for students to take terminal science courses, biological sciences, earth sciences—and never take an interdisciplinary science course at all, or any physical science course."

Mr. Cooksey noted that he did not find significant differences in performance when he examined 9-year-old exercises on the basis of the type of science content covered. "Responses of the 9-year-olds in the areas of biology, physical science, and earth science indicate that these youngsters are about equally knowledgeable in these subjects." He expressed his belief that elementary-aged youngsters are naturally curious, that they observe the surrounding environment. "I don't know where they lose this curiosity as they move to the high school level," Mr. Cooksey remarked, but there are "areas of difficulty" in the higher grades "as far as motivating youngsters to really want to go into the laboratory, to really want to take a part in things that are going on."

As a high school teacher involved in physical science education, Mr. Cooksey appeared to interpret much of National Assessment's first science report as confirmation of what he already believed. "We as science educators and science teachers," he told the NSTA audience, "should make our subject in the physical sciences more attractive from the point of view of actually encouraging youngsters to take the physical sciences."

Are they autonomous learners?

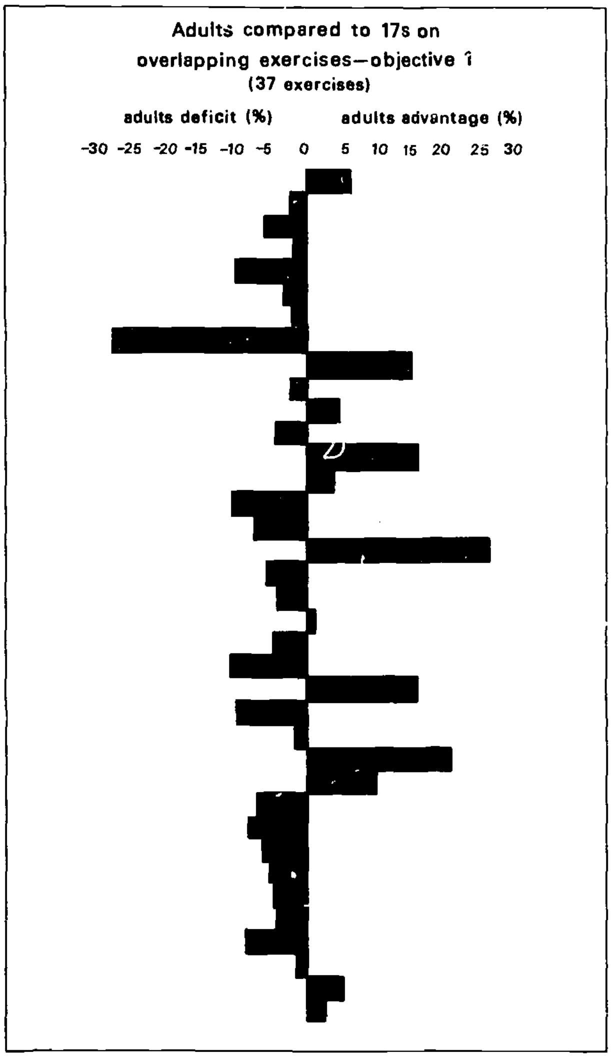
Richard Merrill, president of NSTA and consultant in secondary curriculum for the Mt. Diablo Unified School District in Concord, California, focused the audience's attention on overlapping exercises administered in the science assessment. These were given to two or more ages and were identical or essentially the same, except for minor wording or format differences, thus allowing comparisons of the results across age levels.

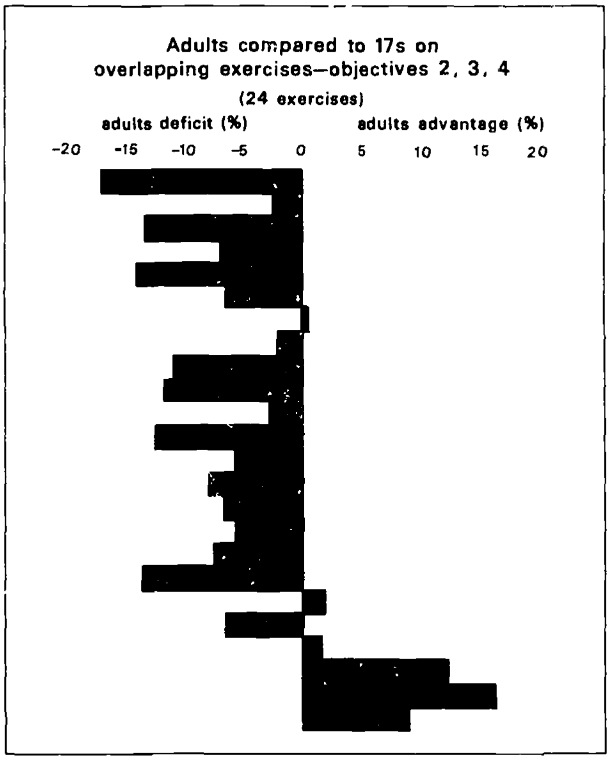
Dr. Merrill showed NSTA members several diagrams that had appeared in the science report. These showed graphically the increase or decrease in success between ages on overlapping Objective 1 exercises. He pointed out that the results between ages 9 and 13 and 13 and 17 indicate considerable growth. But between 17 and adult—"and this is the sad news of the National Assessment study," Dr. Merrill added—there are a large number of exercises on which adults do not perform as well as 17s.

Why the decline in performance between 17s and adults? One easy explanation, said Dr. Merrill, is to take the point of view that reasons, "well, of course—these results are for exercises assessing Objective 1. That's the booklearning, the stuff that you memorize and then forget." Not so, Dr. Merrill pointed out as he showed the audience another diagram that compared the performance of 17s and adults on exercises classed as Objectives 2, 3, and 4. On only six of 24 such overlapping exercises did adults do as well as or better than 17s. (The four science objectives are listed on page 2.)

"Maybe we're teaching better," Dr. Merrill speculated as he offered possible reasons for the drop in adult performance on overlaps. Or if it's not due to better science teaching today than when the adults were in school, "maybe it's just forgetting," he added. But the overlap results do lead one to wonder. "I question," he said, "whether we're developing autonomous learners who continue to learn after they leave school."

In discussing results of exercises for the four objectives, Dr. Merrill cautioned the audience to keep in mind the limited number of exercises for all but Objective 1. (Of the 510 exercises administered to all ages, 345 were classed as Objective 1, 108 as Objective 2, 30 as Objective 3, and 27 as





Objective 4.) Dr. Merrill indicated that he felt National Assessment had been very successful in assessing Objective 1. But he cautioned the audience against placing a great deal of emphasis on results for the other objectives because of the small number of exercises involved. "I think this is a limitation of the study that you have to realize," he said.

Dr. Merrill also cautioned the audience on drawing inferences from several of the exercises designed to assess attitudes. He referred to one exercise that asked 13s to indicate whether they were often, sometimes, or never curious about why things are the way they are in nature. "Often" was the desirable answer, chosen by 8 percent of the 13s. (NAEP's attitude exercises have no "correct" answer; rather, one response is deemed more "desirable" than others.) The majority of the 13s—64 percent—chose "sometimes" as their answer. "I think I probably would have joined the majority on this exercise," Dr. Merrill said. "I'm not disappointed in the results," he explained, "because I don't think the exercise tells us anything—I don't think this is how you measure a 13-year-old's curiosity." He suggested that a better measure might be to confront a 13-year-old with something he has never seen before and find out how many questions he asks about it.

Another exercise asked 17s and adults how frequently they watch television programs dealing with scientific topics. Again the desirable answer was "often," and again "sometimes" was the most frequent response, given by 64 percent of the 17s and 56 percent of the adults. He would have joined the majority on this exercise also, Dr. Merrill indicated. "I don't have that much television time to be able to watch 'often' when this kind of thing goes on."

In spite of his disappointment with some of the attitude exercises, Dr. Merrill felt that the science assessment had yielded much important and useful information. "National Assessment has made a very good beginning, especially with the Objective 1 area, and to some extent with Objectives 2 and 3."

What the student learns

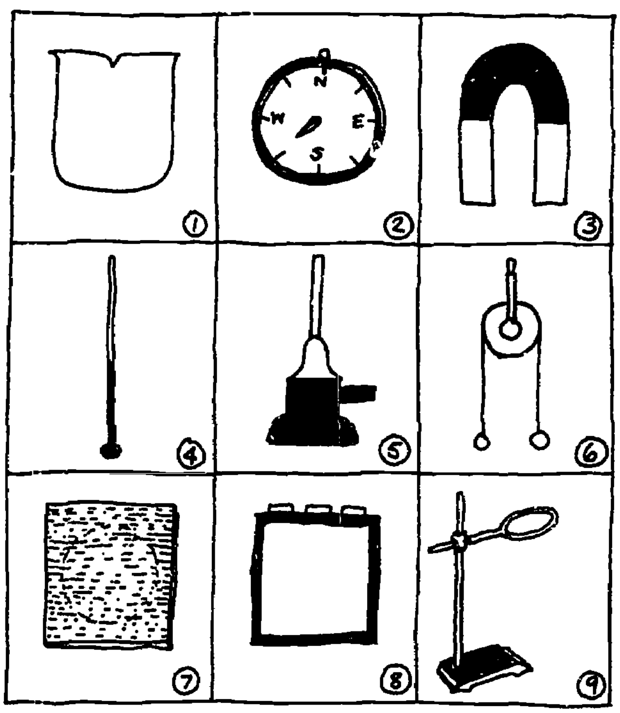
Stanley Williamson, chairman of the department of science education at Oregon State University,

continued

viewed NAEP's science objectives and national results from the standpoint of what implications they might have for science teacher education programs. "I think it's a little unfortunate that the emphasis in this first go-round was placed on Objective 1," Dr. Williamson remarked, "because that's exactly the way our teacher education programs have been organized for the past many years."

Dr. Williamson explained that, generally speaking, the emphasis of teacher education for the last 150 years has been on "what the teacher teaches" rather than on what the student learns—"it's almost as if he did not exist." This is no longer the case, he pointed out. "Whether we like it or not, 'accountability' is the name of the game today." The major emphasis is now placed on what is learned by the student—"and not just the facts," Dr. Williamson added, "but his attitudes, his feelings, his beliefs, his appreciations."

That NAEP's first science assessment included comparatively few exercises assessing Objectives 2 and 3, and only a handful for Objective 4, seemed to underscore what Dr. Williamson regards to be perhaps the greatest need to be met by current teacher training efforts. "We must in our teacher education programs," he said, "find ways and means of preparing teachers to handle Objectives 2, 3, and 4, particularly 4." This "handling," Dr. Williamson seemed to suggest, involves both instructional methodology for achieving the objectives and performance criteria by which attainment can be measured.

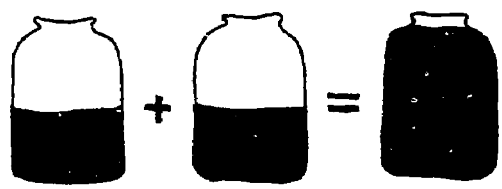


For Dr. Williamson, one of the most important implications of National Assessment's science report seems to be the finger it points at the need for further investigation. ". . . Much research is needed on specific techniques and resources to develop competencies" in the teaching of Objectives 2, 3, and 4, "and on the kinds of science experiences that are performance-based and are transferable to teaching/learning situations."

Where to put the attention

Elizabeth Wood, a scientist who recently retired from Bell Telephone Laboratories, suggested to the NSTA audience that perhaps the greatest utility of National Assessment's science results can come from looking at individual exercises, from trying to find out exactly why particular results occur. "This is the kind of meat we can get out of the assessment, it seems to me," she said. "Can we find out where we are failing?"

Dr. Wood discussed several specific exercises which, in her view, might have very serious implications. One asked 9s what would happen if two pints of water—one with a temperature of



50°F and the other with a temperature of 70°F—were mixed. The correct answer, that the resulting mixture would have a temperature of 60°F, was chosen by only 7 percent of the 9s. What was even more alarming to Dr. Wood than the low percentage of success for this exercise was the fact that 69 percent chose 120°F as the correct answer.

She doesn't believe that 9s don't know the effect on overall temperature of adding equal amounts of cool and warm water, Dr. Wood indicated. "What they *don't* know," she speculated, "is how to read that statement carefully and get the meaning from it."

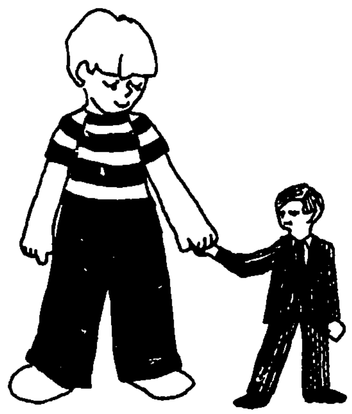
She cited another exercise given to 9s. In it they were asked to choose from a list of items the one that cannot be burned in a fireplace. Iron, the correct answer, was selected by 89 percent, but a full six percent indicated wood as the correct answer. "I don't believe that six percent thought for one minute that wood cannot be burned in a fireplace," said Dr. Wood. Again, she speculated that careless reading was responsible for this result.

Reading in science is quite different from reading in other areas, Dr. Wood told the audience. "In their reading courses," she explained, "students are taught to skim and grab the tops of things for an approximate impression of what is going on." The emphasis educators often seem to place on rapidly reading questions and providing answers "discourages thoughtful consideration," Dr. Wood suggested. "We must find a way of slowing down the answering process." If students can be taught to read carefully and look for the meaning in science courses, she said, they will be gaining "a skill that will stand them in good stead the rest of their lives."

Dr. Wood invited the audience to speculate with her on the results for another exercise, this one given to 13s. Nine simple diagrams of 9 simple pieces of equipment were presented (including items such as a magnet, beaker, thermometer, and stopwatch). The 13s were asked to choose the combination of objects that would enable them to determine the boiling point of water. Only 36 percent identified the correct group. "Why?" asked Dr. Wood. The exercise writer "couldn't have chosen a simpler laboratory process," she noted. Did the majority fail because they did not know what is meant by the boiling point of water? Was it because they were unable to recognize simple, two-dimensional representations of three-dimensional objects?

These are the kinds of questions readers of NAEP's national results can take hold of, Dr. Wood suggested. If, for example, it were found that 13s cannot recognize line diagrams, "this could revolutionize the way textbooks are written," she pointed out.

Dr. Wood cited still another exercise whose results might have some serious implications. Thirteens and adults were given five line graphs and asked to indicate the one that showed the average pattern by which children's height increases with age. Only 27 percent of the 13s and 39 percent of the adults responded correctly. Dr. Wood pointed out that large numbers of respondents (30 percent of the 13s and 15 percent of the adults) chose graphs that indicated a decrease in height as age increases.



"We had better be teaching them how to interpret a simple graph . . . before we let them get muddled ideas in their heads about seeing atoms," Dr. Wood cautioned. (Earlier she had cited an exercise on which 44 percent of 13s chose one of the following wrong answers: that atoms can be seen with the naked eye, a magnifying glass, or a microscope.)

Dr. Wood suggested that science education focus first on subject matter that helps students to become involved in careful observation and rational thinking. "Only when they have repeated experience in finding out for themselves," Dr. Wood remarked, are students "ready to learn what others have found out by slow, careful methods of investigation."

"The published results of this first assessment are rich in solid information . . . that shows on a national, statistically significant scale where we need to focus our attention in science teaching," Dr. Wood concluded. "And three years from now, the second round of results will tell us even more." □

New address

After June 30, National Assessment will be located in Denver, Colorado. The project will join its parent organization, the Education Commission of the States.

Publications mailing operations will remain in Ann Arbor for several months. Requests for specific printed materials should therefore be sent to the old address:

National Assessment Publications
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2222 Fuller Road
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All other requests and correspondence should be sent to:

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300 Lincoln Tower
1860 Lincoln Street
Denver, Colorado 80203

Calendar

June	15-16	Alaska Association of School Administrators	Alycaska, Alas.	G. Brain
July	7-9	Education Commission of the States Annual Meeting	Boston, Mass.	NAEP Staff
	14	N. W. Cleveland Conference	Pullman, Wash.	G. Brain
	19-30	National Assessment Seminar	Corvallis, Oreg.	J. Hazlett
	21	New York State School Superintendents Session on Accountability	New Paltz, N.Y.	D. Foreman
	26-27	Tuskegee Summer Institute	Tuskegee, Ala.	F. Womer
August	8	National Academy of School Executives	Las Vegas, Nev.	G. Brain
	28	Puget Sound Administration Conference	Tacoma, Wash.	G. Brain

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